

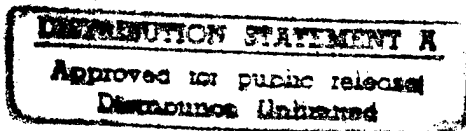
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A CLASH OF MILITARY CULTURES:
GERMAN & FRENCH APPROACHES TO TECHNOLOGY
BETWEEN THE WORLD WARS

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Introduction

The First World War was a period of extraordinarily rapid technological development. Military technology had changed dramatically in the decades before World War I, but even the most perceptive pre-war military thinkers of 1914 were unable to predict the pace of wartime technical development. The militaries of World War I had to adapt to the emergence of the airplane, motor vehicle, tank and poison gas as major new weapons. Commanders, general staffs and war departments had to try to master the variety of new technology and adapt technology to operations.

The period in between the world wars was a time of extraordinary technological development for the world's militaries. World War I had proven to be a technological catalyst. Such weapons as the tank, which was introduced in the war, enjoyed rapid development in the 1920s and 1930s. Accelerated by the war, motor vehicle development progressed, while every army engaged in motorization experiments. Radios and electronics passed out of their infancy as Britain and Germany developed radar. Most dramatic of all was the evolution of the airplane from a useful auxiliary weapon into a very powerful and decisive arm of the military.

The French military was extremely successful in adapting to technology during World War I. In many respects, the French effort in this regard equalled, and in several instances surpassed, the German. Deficient in heavy artillery at the start of the war, by 1917-1918 the French Army had created a superb heavy artillery arm.¹ French vehicle production exceeded the German, and by 1918, the French Army was more advanced in motorization.² The most dramatic difference

¹In 1917, the French Army deployed the Canon de 155mm GPF as the standard heavy gun. With a range of 19,500 meters and a 43kg shell, it was highly respected by the Germans and the Allies. See Peter Chamberlain and Terry Gander, **Heavy Artillery**, N.Y.: ARC (1975), p. 17. On other French guns, see pages 14-19.

²Werner Oswald, **Kraftfahrzeuge und Panzer der Reichswehr, Wehrmacht und Bundeswehr**, Stuttgart: Motorbuch Verlag

between the two armies was in the development of armored forces. The French General Staff initiated development of a French tank program in 1914.³ During the war, the French produced 4,300 tanks, more than any other power.⁴ In contrast, the Germans never deployed more than a few dozen tanks, and of these, only 20 were of German manufacture.⁵ Another French success story was their effectiveness in designing and producing high-quality aircraft. The military leadership and civilian industrialists demonstrated a high degree of innovation in effectively standardizing aircraft types and engines. France led the world in aircraft engine production and quality.⁶ By 1918, the French had designed and built the first supercharged engine.⁷ In design, the French equalled the Germans, with such rugged, effective and swift aircraft as the Spad VII, Spad XIII fighters and the Breguet 14 bomber.⁸ Indeed, the quality and quantity of French aircraft design and production enabled the Allies to gain air superiority in the latter part of the war. Due to the inefficiency of British aircraft design and production, the British had to rely upon the French for many aircraft and engines. As late as 1918, British squadrons on the Western Front flew Spads and Nieuports into action.⁹ By the final year of the war, the French military demonstrated considerable skill in utilizing new technology

(1975), pp. 10-11. In 1918, the French Army employed 100,000 motor vehicles, not including tanks, on the West Front. The German army motor vehicle total during the war did not exceed 40,000 in use.

³On Col. Estienne, See Kenneth Macksey, ed., The Guinness Book of Tank Facts, Enfield: Guinness Publishing (1980), p. 28.

⁴Ibid., p. 45.

⁵Werner Oswald, Kraftfahrzeuge und Panzer, pp. 36-39.

⁶John Morrow, The Great War in the Air, Wash., D.C.: Smithsonian Institution Press (1993), pp. 369-371. In World War I, the French built 52,000 planes and 88,000 engines. The Germans built approximately 48,000 planes and 43,000 engines.

⁷Charles Christienne and Pierre Lissarrague, A History of French Military Aviation, Washington, D.C.: Smithsonian Institute Press (1986), p. 117.

⁸On French aircraft at the end of the War, see John Morrow, The Great War in the Air, pp. 363-371, and Charles Christienne and Pierre Lissarrague, History of French Military Aviation, pp. 117-122 and 155-157.

⁹In 1918, Squadrons 1, 19, 23, 29 and 60 of the Royal Flying Corps and RAF flew Nieuport 17s, Spad VIIIs and Spad XIIIIs on the Western Front. See Christopher Shore and Norman Franks, Above the Trenches, London: Grub Street Publishers (1990), pp. 30-36.

on the battlefield. The French Army demonstrated operational finesse in the successful counterattack at Soissons on July 18 and 26, 1918. French forces, supported by 571 tanks and masses of aircraft, drove a deep wedge into the German drive on Paris.¹⁰ French infantry and tanks also took part in the attack at Amiens on August 8, 1918: the Allied Offensive that decisively broke the German Front. During the last two months of World War II, the American offensive at St. Mihiel and the Meuse Argonne relied upon the French for tank, air and artillery support.¹¹

Twenty-two years later, the French had lost the technological edge they had enjoyed in 1918. The French ground forces were well-equipped, but their commanders' inability to effectively use the weapons was apparent. In the field of aviation, the technological disparity was significant, with the Germans fielding a force which was both qualitatively and quantitatively superior. In numerous aspects of technology, the German military had shown itself far more innovative and effective in the development and employment of equipment.

My purpose in this paper is to explore the background of two contrasting military cultures, the French and the German, and compare their approaches to the development and adaptation of technology. I will first outline the state of comparative technological development of the French and German armies and their forces in 1939-1940, and investigate some of those factors that brought those forces to their relative positions. The specific lines of investigation will follow: first will be the influence of doctrine upon technology; second, the influence of military organizational systems upon technology; finally, the influence of the general staff cultures upon technical development.

The State of French and German Military Technology in 1940.

In the 1920s, the French had a clear lead in motorization and tank development. The French motor industry was one of the larger motor industries, and was highly innovative.¹²

¹⁰ Kenneth Macksey, The Guinness Book of Tank Facts, p. 37.

¹¹ At the St. Mihiel Offensive of the U.S. Army in September 1918, the French provided 185 tanks and the U.S., 174 tanks. The French supported the U.S. Offensive in the Meuse-Argonne in September/October 1918 with 750 tanks. See Kenneth Macksey, The Guinness Book of Tank Facts, p. 231.

¹² See Patrick Fridenson, "Les relations entre les industries automobiles française et allemande des années 1880 aux années 1960", in Frankreich und Deutschland: Forschung, Technologie und industrielle Entwicklung im 19. und 20. Jahrhundert, Yves Cohen and Klaus Manfrass, eds. Munich: C.H. Beck'schen Verlag (1990), pp. 334-342, especially

For example, in the 1920s, Citroen produced the world's first practical half-track vehicles.¹³ The military, following the success of French motor production and employment in the World War, had numerous commissions devoted to studying and implementing motorization.¹⁴ In tank development, the French capitalized upon their advantage gained in World War I, and several commissions were given a mandate to develop tanks. French tank design in the 1920s was clearly at the cutting edge, with the design for the Char B heavy tank. The Char B would eventually be deployed in the 1930s, carrying a 75mm and a 47mm gun.¹⁵

In the air, the French also enjoyed a significant technological advantage. In the 1920s, the French air force was the largest in the world.¹⁶ The French air motor industry led the world, and in the mid-1920s, the French held many world records in aviation. The National Aeronautical Institute, founded in 1909, was nationalized and put under the direction of the Air Ministry in 1928. The Institute continued to produce highly qualified aeronautical engineers.¹⁷

Both in ground forces motorization and in aviation technology, the French lost their edge in the late 1920s-early 1930s. In Germany, the auto industry--which had been far smaller than the French auto industry of the 1920s--forged ahead. By the early 1930s, with subsidies and incentives from the new Nazi regime, the German auto

pp. 335-336.

¹³The French half-track technology of the 1920s was so admired by the Germans that the German Maffei Company licensed the French half-track system in 1927, and produced a German model by 1930. See Walter Spielberger, Die Motorisierung der deutschen Reichswehr 1920-1935, Stuttgart: Motorbuch Verlag (1979), pp. 145-151.

¹⁴For a detailed review of French motorization efforts 1919-1939, see Ministère de la Defense, Les Programmes d'Armement de 1919 à 1939, Château de Vincennes (1982), pp. 260-329.

¹⁵By 1940, 365 Char B Tanks were built. See Christopher Foss, ed., An Illustrated Guide to World War II Tanks and Fighting Vehicles, N.Y.: Arco Publishing (1981), pp. 16-19.

¹⁶In 1923, France was rated as the strongest aeronautical power. It had an Air Force of 123 squadrons, with 1,050 modern aircraft. See Aeronautical Chamber of Commerce of America, Aircraft Year Book 1924, N.Y. (1924), pp. 185-193.

¹⁷The National Aeronautics Institute produced about 100-150 aeronautical engineers a year in the 1920s and 1930s, although many only had a 2-year course in engineering. See l'École Nationale Supérieure de l'Aéronautique, Livre d'Or de l'École Nationale Supérieure de l'Aéronautique: Cinquante années d'existence (1909-1959), pp. 59-60 and 65-66.

industry became larger than the French.¹⁸ The French were, however, able to keep a high standard in developing tank technology. For example, the French tanks of the mid-1930s were fitted with the world's first cast turrets, and the French tanks of the 1930s had the most sophisticated steering systems of the era.¹⁹ The Germans, however, were able to match the level of French tank technology. For example, in 1936 the Panzer II and III were designed with the world's first torsion-bar suspension system.²⁰ In artillery, both countries demonstrated a rough parity in gun quality by 1940. In the post-World War I era, both the French and the German armies had developed medium and heavy guns which were efficient and effective upon the battlefield in 1940.²¹ In other aspects of motorization, the French fell behind. Having once led the world in half-track production, the French virtually ended development of the half-track in 1933. Starting behind the French, the Germans licensed their technology and then forged ahead with their own, innovative designs. By 1940, a wide variety of half-track vehicles was assigned to their armored and motorized divisions.²² The Germans took the lead in other areas, as well, including armored cars, armored command vehicles, and tracked assault guns, while French development in these areas remained relatively static. The greatest disparity in ground forces equipment between the French and the Germans was in communications equipment. The French developed relatively few radio systems in the interwar period, and devoted very little money to developing

¹⁸ Maurice Larkin, France Since the Popular Front, Oxford: Clarendon Press (1988), p. 389. Between 1925-1929, France produced an average of 207,000 motor vehicles per year to Germany's 90,000. Between 1930-1934, France produced 193,000 per year to Germany's 101,000. From 1935-1939, the French produced 200,000 motor vehicles per year to Germany's 304,000.

¹⁹ R.M. Ogorkiewicz, Armoured Forces, N.Y.: Arco Publishing (1970), pp. 177-178 and 336.

²⁰ Ibid., p. 343.

²¹ On German and French artillery of the interwar period, see Peter Chamberlain and Terry Gander, Light and Medium Field Artillery, N.Y.: Arco Publishing (1975), pp. 13-30, also Peter Chamberlain and Terry Gander, Heavy Artillery, N.Y.: Arco Publishing (1970), pp. 14-26.

²² The German Army began development of half-tracked vehicles in 1926. By 1937, mass production of the highly-effective Sdkfz 250 and Sdkfz 251 had begun. See Duncan Crow, ed., Armored Fighting Vehicles of Germany, N.Y.: Arco Publishing (1978), pp. 161-172, and John Milsom, German Half-Track Vehicles of World War II, N.Y.: Hippocrene Books (1975), pp. 6-7.

communications equipment.²³ Yet, a high priority was assigned to the development of communications equipment which would be set in fixed installations along the Maginot Line.²⁴ The Germans, on the other hand, placed a very high priority upon developing communications equipment, and produced a wide variety of effective radios for ground forces, infantry, artillery, aviation and tanks.²⁵ As of 1940, only French heavy tanks had radios, whereas all German tanks had radios, and numerous other armored cars and vehicles, as well.

With the exception of communications, however, the French Army was not badly equipped in 1940. In fact, they possessed good guns, good tanks for the era, and several armored and motorized divisions. The French Army of 1940 can be said to have had a modern level of motorization. In their approach to motorization, the German and French armies were actually very similar. Both armies were supportive of motorization, and studied it intensively. Both were influenced by national strategic considerations, for both countries were net importers of oil, and were concerned about assuring a supply of oil in case of war.²⁶ This

²³Between 1923 and 1939, the French military devoted only 0.15% of their military budget to communications equipment. See Robert Doughty, "The French Armed Forces, 1918-40", in Military Effectiveness, vol. II, Boston: Unwin Hyman (1988), pp. 39-69, especially p. 58. The French had commercial technology which could have been exploited for the military. In 1931, a commercial UHF link was opened between Britain and France. The UHF frequencies, however, though used extensively by the Germans, were not developed by the French. See Tony Devereux, Messenger Gods of Battle, London: Brassey's (1991), p. 84.

²⁴In the interwar period, one of the largest of the French radio procurement programs was for the OCTF, and for the R and F type radios and receivers (650 radios) for the Maginot Line fortifications. Only a handful of radios were planned for the Char B and R 35 tanks. See Ministère de la Defense, Les Programmes d'Armement, p. 416.

²⁵During the 1920s and early 1930s, the Weapons Office and Communications Inspectorate developed a broad family of effective radios for the tactical use of the Army. See Adolf Reinicke, Das Reichsheer 1921-1934, Osnabrück: Biblio Verlag (1986), p. 196.

²⁶On oil and French strategic planning in the interwar period, see R. Nayberg, "La Problématique du revitaillement de la France en carburant dans l'Entre-deux-guerres: naissance d'une perspective géostratégique", in Revue Historique des Armées, No. 4 (1979), pp. 5-28. For a good overview of the strategic effect of the oil supply on German

concern for oil, as well as the high cost of motorization, ensured that both armies would motorize gradually, and would still use primarily horse-drawn transport for their infantry divisions in 1940.

One interesting aspect of the French and German concern about oil imports was that Germany and France were the only nations in the interwar period to develop diesel aircraft engines. Neither the French nor German diesel aircraft engines were effective, though they did have the virtue of using considerably less fuel than the high-performance engines of the era.²⁷ Both armies, employing common sense, chose the artillery branches as the first priority for army mobilization. The overall effect was a practical approach to motorization by France and Germany.

While the disparity of technology between ground forces in 1940 was serious, in the air this disparity was, for the French, catastrophic. As to aircraft types, in 1940 the majority of the French aircraft in service were far inferior to their German counterparts. For example, the Bloch 152, the Morane Saulnier 406, and the Curtiss Hawk P 36 fighter aircraft were all inferior to the German Me 109 in 1940, and the French bomber force, the Amiot and Farman Bombers, did not come close in performance to the German bombers.²⁸ The

motorization, see Richard DiNardo, **Mechanized Juggernaut or Military Anachronism?**, Westport: Greenwood Press (1991), pp. 7-9.

²⁷By the 1930s, the Germans had developed the Mercedes-Benz DB 602, a 16 cylinder diesel aircraft engine rated at 1,320 horsepower. The French developed the Clerget 16H, a 16 cylinder diesel aircraft engine rated at 2,000 horsepower. See Paul Wilkinson, **Aircraft Engines of the World: 1941;** N.Y.: Paul Wilkinson (1941), pp. 104-105 and 168-169. The Germans took the world lead in diesel aircraft engines. The Ju 86 bomber, which first flew in 1934, was powered by the Jumo 205 Diesel Engine. It had a low power-to-weight ratio, but low fuel consumption. See Green, **Warplanes of the Third Reich**, p. 414.

²⁸The Bloch 152 Fighter, a mainstay of the Armée de l'Air in 1940, had a maximum speed of 316 Mph., and an armament of 2, 20mm cannon and 2 machine guns. It was slower than even the German Me 110 Heavy Fighter. See Kenneth Munson, **Fighters 1939-45**, London: Blandford (1969), p. 39. The Amiot 143 Bomber, used by the French in 1940, was designed in the late 1920s, and had a maximum speed of 193 Mph. and a bombload of 1,300 Kg. The Bloch 210 was designed in 1932, had a maximum speed of 200 Mph. and a bombload of 1,600 Kg. The primary German bombers of 1940 were the Heinkel He 111 and the Dornier Do 17. The Heinkel He 111 had a maximum speed of 252 Mph. and a bombload of 2,500 Kg. The Do 17 was faster, at 255 Mph. Both clearly outclassed most of the French

only French bomber relatively equal to its German counterparts in 1940 was the Loire 45, roughly equivalent to the German Heinkel 111, Dornier 17 and Junkers 88 bombers.²⁹ The Dewoitane 520 Fighter, which entered production in 1940, was the only aircraft that could hope to match the Me 109.³⁰ The French Portez 633 heavy fighter was inferior in speed and reliability to the Me 110 of the Germans.³¹ In the field of dive bombers, the French belatedly manufactured and bought a mere handful of dive bombers by 1940, in contrast to the large German dive bomber program, which enabled the Luftwaffe to employ over 300 Ju 87s for the campaign in France.³² As an overall assessment, the French Air Force in 1940 was approximately 3 years behind the Germans in aircraft development and deployment. The Loire 45 only entered serial production in 1940, whereas the German Heinkel 111s and Dornier 17s had entered serial production in 1937. The Dewoitane 520, a project initiated at the same

bomber force. See Enzo Angelucci and Paolo Matricardi, **Combat Aircraft of World War II 1933-1937**, N.Y.: Military Press (1987), pp. 22 and 30.

²⁹The LO 45 (also known as the Leo 451) was a good medium bomber, with a maximum speed of 250 Mph. and a bombload of 1,500 Kg. Although it compared well with German aircraft in 1940, only 5 were operational as of September 1939, and perhaps only 110 were operational by June 1940. See Enzo Angelucci, **Rand McNally Encyclopedia of Military Aircraft**, N.Y.: Gallery Books (1990), pp. 281-282.

³⁰The Dewoitane D 520 had a maximum speed of 326 Mph. and carried a 20mm gun and four machine guns. The Me 109 E aircraft it faced was faster, at a maximum speed of 357 Mph., and had two 20mm cannon and two machine guns. See Kenneth Munson, **Fighters 1939-45**, pp. 56 and 64.

³¹See Kenneth Munson, **Fighters 1939-45**, pp. 82 and 88. The Portez 63, a twin-engine fighter/attack aircraft, had a top speed of 264 Mph., 6 machine guns and a 180 Kg. bombload. The Me 110 Fighter was better-powered than the Portez 63, with a top speed of 336 Mph., and carried heavier armament: 2, 20mm cannon and 5 machine guns. The Me 110 also had a longer range, and a much heavier bombload of 1,000 Kg. See also Hans Redemann, **Innovations in Aircraft Construction**, West Chester, Penn.: Schiffer Military History (1991), pp. 58-65.

³²Peter Smith, **Dive Bomber! An Illustrated History**, Annapolis: Naval Institute Press (1982), pp. 92 and 101. In May 1940, the French Navy possessed five squadrons, 60 aircraft each, of Loire LN 410 and Vought Vindicator Dive Bombers. Both the Vindicators and Loires were far inferior in bombload and performance to the Ju 87; for example, the LN 410 had only a 500 lb. bombload to the Ju 87-B's 1,100 lbs.

time as the Me 109, only entered production in 1940,³³ while the Me 109 entered serial production in 1937. In almost every case, it took the French two to four years longer to develop and deploy an aircraft model in the 1930s. In the establishment of a basic aviation infrastructure, the French Air Force was as much as ten years behind that of the Luftwaffe. In 1939, France possessed only one paved runway in the entire country.³⁴ In 1933, France had only 2 radio beacons for aerial navigation.³⁵ The French got off to a very late start in developing a modern infrastructure in 1936, when they initiated a program to improve aerial navigation for civil and military aviation; however, little was accomplished by 1940.³⁶ In contrast, even in the 1920s, the Germans had developed the most sophisticated aviation infrastructure in Europe. By 1927, Lufthansa was, by far, the largest passenger and cargo carrier in Europe.³⁷ In 1927, Lorenz all-weather landing systems were introduced for airport operations.³⁸ By 1931, 17 airports had Lorenz systems.³⁹ German development of aviation instruments, including gyroscopic instruments, in the 1920s and early 1930s was equal to that of the United States.⁴⁰ Germany in 1940 possessed numerous paved runways.⁴¹

³³ Enzo Angelucci, The Rand McNally Encyclopedia of Military Aircraft, N.Y.: Gallery Books (1990), p. 222.

³⁴ See Charles Christienne and Pierre Lissarrague, A History of French Military Aviation.»

³⁵ Ibid.

³⁶ Ibid.

³⁷ Ernst Kredel, "Der deutsche Luftverkehr", in Luftfahrt ist Not!, ed. Ernst Jünger, Leipzig: Deutschen Luftverbandes (1931), pp. 264-277.

³⁸ Helmuth Schmidt-Reps, "Das Funkwesen in der Luftfahrt", in Luftfahrt ist Not!, pp. 278-289, esp. p. 282.

³⁹ Ibid., p. 283.

⁴⁰ See Martin Mäder, "Technische Hilfsmittel für die Navigation und Steuerung an Bord neuzeitlicher Verkehrsflugzeuge", in Luftfahrt ist Not!, pp. 305-322. By 1930, it was common for German civil aviation to use artificial horizons, gyrocompasses, ADF and Lorenz beam navigation systems.

⁴¹ By 1937, German civil aviation had a network of 29 ADF beacons and 29 radio control stations, as well as 18 illuminated civilian airports. Heinz Orlovius, ed., Die Deutsche Luftfahrt Jahrbuch 1937, Frankfurt a.M.: Verlag Fritz Knapp (1938), pp. 94. By 1938, the network of directional beacons had grown to 34, while 16 airports had ultra short wave instrument landing systems--and these figures do not include the navigation systems of the Luftwaffe. See Heinz Orlovius, ed., Die Deutsche Luftfahrt

The only aspect of aviation where a rough equality existed was in aircraft engine development. The French had always had a strong engine industry, and in 1940, had some effective 2,000-horsepower engines in development.⁴² In other areas, however, the French declined even to compete with the Germans. The most dramatic examples of this were in the development of radar, and of the jet aircraft. At the outbreak of the war, the French navy had developed radar technology, but the French air force had no radar program.⁴³ In contrast, the Germans in 1939 were already producing advanced radar sets, and were deploying radar for air defense.⁴⁴

During the interwar period, perceiving that the piston engine had specific speed limitations which were rapidly being approached by the major powers, Heinkel initiated production of both jet engines and jet aircraft. With little government financing and only a handful of engineers, Heinkel developed the first jet engine program in Germany in the mid-1930s.⁴⁵ The culmination of their efforts came in August 1939, when the Heinkel 178 became the first jet aircraft to fly.⁴⁶

Finally, in the matter of operational forces, there are other notable disparities between the French and the German interwar forces. In 1935, the Germans--following the lead set by the Soviet Union--began to develop airborne forces.⁴⁷

Jahrbuch 1938, Frankfurt a.M.: Verlag Fritz Knapp (1939), pp. 108-124.

⁴²Paul Wilkinson, **Aircraft Engines of the World**, pp. 120-121. By 1940, the French Air Ministry had developed the Hispano-Suiza 24Y, rated at 2,200 horsepower.

⁴³In 1939, the French had developed seaborne radar for the Liner Normandie. See Kenneth Macksey, **Technology in War**, N.Y.: Prentice-Hall Press (1986), p. 120.

⁴⁴Werner Niehaus, **Die Radarschlacht 1939-1945**, pp. 29-34 and 73-75. The German radar program started under a naval contract in 1929. By 1934, primitive radar sets had been tested and in 1936, the Luftwaffe initiated the radar that would become the "Freya". An early Freya was tested in the 1937 Wehrmacht maneuvers. By 1939, Freya radars had been deployed to detect British bomber raids against Wilhelmshafen.

⁴⁵Walter Boyne, **Messerschmidt Me 262**, Wash., D.C.: Smithsonian Institution Press (1980). A small research team led by von Ohain began developing a jet engine, the He S-3B, in April 1936, and completed and ran the engine in March 1937. The total cost was approximately \$20,000.

⁴⁶Hans Redemann, **Innovations in Aircraft Construction**, esp. pp. 106-109.

⁴⁷Volkmar Kuhn, **German Paratroops in World War II**, London: Ian Allan, LTD. (1978), pp. 8-14.

By the outbreak of the war in 1939, a full airborne division had been formed by the Luftwaffe, and other large units were in the process of formation.⁴⁸ In contrast, by 1939 the French Air Force had formed a small group of 175 airborne soldiers, and employed them on one maneuver. Otherwise, the French Army and Air Staff exhibited little interest in airborne or air-landing troops.⁴⁹

In anti-aircraft technology, France and Germany, which had been approximately equal at the end of World War I, developed a family of light anti-aircraft guns of 20-37mm. In production, however, the French placed little emphasis upon the anti-aircraft arm, and by the outbreak of the war, the French possessed a mere handful of light anti-aircraft guns, relative to the Germans. In the field of heavy anti-aircraft guns, the French in 1922 had developed an excellent high-powered 90mm gun, but had then halted further development of heavy anti-aircraft guns and stayed with the low-velocity, obsolete 75mm.⁵⁰ As for the Germans, by 1932, Krupp and Rheinmetall had developed the famous 88mm anti-aircraft gun. By the beginning of World War II, the French Army had only 4,000 anti-aircraft guns of all types versus over 3,000 heavy, and 10,000 light anti-aircraft guns for the German forces.⁵¹

The Influence of Doctrine on French and German Interwar Technology.

Both the French and the German armies of the interwar period provide useful illustrations of the dominance of doctrine in the process of developing military technology. Both the French and the Germans developed a clear and explicit doctrine, and in both cases, the armies successfully developed the technologies that fit their own doctrines. The interwar French operational doctrine, as expressed in the **Provisional Instructions On the Tactical Employment of**

⁴⁸In 1938, the German paratroop units were organized as the 7th Air Division. In 1939, the 22nd Infantry Division started retraining as an air landing division. In 1940, these two airborne divisions would lead the German assault on the Netherlands. See Volkmer Kuhn, **German Paratroops**, pp. 17-19.

⁴⁹P. Buffotot, "La Perception du Réarmement Allemand par les Organismes de Renseignements Français de 1936 à 1939", in **Revue Historique des Armées**, No. 3 (1979), pp. 173-184.

⁵⁰Charles Christienne and Pierre Lissarrague, **A History of French Military Aviation**, p. 310.

⁵¹Michel Forget, "Die Zusammenarbeit zwischen Luftwaffe und Heer bei den französischen und deutschen Luftstreitkräften im Zweiten Weltkrieg", in **Luftkriegführung im Zweiten Weltkrieg**, ed. Horst Boog. Herford: E.S. Mittler Verlag (1993), pp. 479-526, esp. pp. 510-511.

Large Units (1921),⁵² is described as the *bataille conduite*, or the methodical battle. In the 1921 Regulations, the French General Staff expressed the view that technology had so changed the battlefield that firepower was now the primary element in warfare.⁵³ Firepower made the defense extremely powerful. The French Army, however, also determined that only the offense could bring victory and a successful conclusion to the campaign. Therefore, a great part of the French doctrinal thought was tied up in the methodical battle, which is in essence an offensive doctrine. The French offensive doctrine of the interwar period had the following characteristics:

- Strict, centralized control by the core and the army, with little room for initiative of junior commanders;
- Since firepower dominated the battle, artillery support would be massive, centralized and concentrated;
- The infantry would move forward by short bounds of 5 kilometers or so, under massive artillery support, and at that point, the advance would halt in accordance with specific phase lines, so that the artillery could deploy forward, and the battle could be rejoined, on successive days.

Under the terms of the methodical battle, commanders such as Gamelin, Petain and Weygand believed that the correct employment of doctrine could ensure victory.

The methodical battle had its origins in the campaigns and methodology of 1918. After the disasters of 1916 and 1917, it seemed that the French Army had finally discovered the secret of success on the battlefield, by carefully planned offensives with massive firepower. These forerunners of the methodical battle proved their effectiveness in the Summer and Fall of 1918. In its essence, the tactics of late 1918 were geared to the minimization of casualties of the French Army. Tanks, in fact, played a very large role in the French methodical battle. In the interwar period, studies on the armor force developed the corollary to the French

⁵²Ministère de la Guerre, **Instruction Provisoire sûr l'Emploi Tactique des Grande Unités**, October 6, 1921.

⁵³Ibid., Chapter III, Paragraph 115: "Fire is the most important factor in battle. It destroys or cripples the enemy. Attack means carrying the fire forward. Defense is fire that stops."

dogma: namely, that infantry would not in fact be able to successfully advance without strong tank support.⁵⁴ The French Army doctrine was couched in the terminology of science, or more accurately, pseudo-science. Articles and discussions within the Army concerning the methodical battle contained numerous tables and formulae, which were published as appendices to the doctrine.⁵⁵ For example, various attacks required specific gun frontages per square kilometer before an attack could be initiated.⁵⁶ The effectiveness of the Maginot Line defenses, in another case was illustrated by tables demonstrating the number of rounds from German heavy guns that were necessary to knock out each armored casement. In this example the number of rounds was so large, one could conclude that the Maginot Line was effectively unbreakable.⁵⁷ In yet another case, mathematical formulae were used to prove the effectiveness and superiority of anti-tank guns defending against a German armored attack.⁵⁸

The French Army spent considerable time, effort and money during the interwar period to develop the necessary artillery and tank arms which would support the methodical battle. The Army, in 1940, given the high priority of the anti-tank gun in French doctrine, was equipped with good

⁵⁴E. C. Kiesling, "Reform?--Why?: Military Doctrine in Interwar France.", Paper presented to the SMH, April 8, 1994, p. 11.

⁵⁵A typical product of the French scientific approach to war is found in the 1930s writings of General Narcisse Chauvineau. An attack on a continuous front required a 3:1 superiority in infantry, a 6:1 superiority in artillery and 15:1 superiority in shells. See Alvin Coox, "General Narcisse Chauvineau: False Apostle of Prewar French Military Doctrine", in Military Affairs, February (1973), pp. 15-19, especially p. 16.

⁵⁶Robert Doughty, The Seeds of Disaster, pp. 102-103.

⁵⁷The French calculated the destruction of each point of a fortress' outer works would require 100-150 rounds of 280-400mm artillery shells. An armored strongpoint in a fortress required 400 rounds of 320, 370 or 400mm mortar shells to be destroyed. See "Französische Anschauungen über Angriff und Verteidigung an Festungsfronten", in Militärwissenschaftliche Rundschau, Issue 5 (December 1939), p. 702.

⁵⁸E. C. Kiesling cites a 1937 French study that overestimated the range and stopping power of a 25mm gun. The French posited a 1,000 meter effective range, and a rate of fire of 15 rounds per minute, with a 25% hit rate. Thus, the French estimated, 19 of 30 German attacking tanks would be destroyed by a single French antitank gun in a model battle. See E. C. Kiesling, "Reform?--Why?", pp. 14-15.

anti-tank guns.⁵⁹ Since rapid movement and maneuver were not part of the French interwar doctrine, however, very little effort was devoted to developing radio communications for the Army.

The development of French motor vehicles provides a useful illustration of the superiority of doctrine over technology. The Army used early model half-tracks in experiments of the 1920s, and these greatly impressed the German observers.⁶⁰ Half-tracks were most suitable for rapid operational maneuver and motorized units, however, which at the time were not emphasized in French doctrine. Thus, deployment of half-tracks was dropped for lack of interest. Armored cars played a relatively minor role in French doctrine as well, because reconnaissance had less importance in the French doctrine. As a result, the high-quality Panhard armored cars of the 1930s were given a low priority, although the quality of the product was technically equal to that of the Germans.⁶¹

Yet another case of the primacy of doctrine over technology is the example of antiaircraft guns. Anti-aircraft was the responsibility of the army's Artillery Directorate. The army placed little confidence in airpower as having a decisive effect upon the battlefield. Gamelin himself believed that the losses of aircraft in the first few weeks of the war would be so heavy, that airpower would cease to be an important factor in the battle.⁶² Therefore, the

⁵⁹On the French antitank gun program, see Ministère de la Defense, Les Programmes d'Armement, pp. 342-351. General Gamelin made production of the 25mm anti-tank gun a top priority in the 1938 army armaments budget. See Henry Dutailly, "La Puissance Militaire de la France en 1938", in Revue Historique des Armées, No. 3 (1983), pp. 5-9. See also Franz Kosar, Panzerabwehrkanonen 1916-1917, Stuttgart: Motorbuch Verlag (1980), pp. 55-60.

⁶⁰German officers observing the 1922 and 1924 French maneuvers were impressed by the new French vehicles and equipment, but held a low opinion of the French tactics for the equipment. See T-3 Truppenamt, "Die französischen Herbstmanöver 1922", September 11, 1923, in BA/MA, RH 2/1547, also T-3 Truppenamt, "Die französischen Herbstmanöver, 1924", December 10, 1924, in BA/MA, RH 2/1547.

⁶¹In 1940, the Germans had about twice as many armored cars as the French: 350 French to 600+ German. See R.M. Ogorkiewicz, Armoured Forces, pp. 432-434.

⁶²In 1938, General Gamelin commented, "The role of aviation is apt to be exaggerated, and after the early days of war the wastage will be such that it will more and more be confined to acting as an accessory to the army", as cited in

French lagged behind in the development of antiaircraft guns.⁶³

French Air Force Doctrine and Technical Development.

The technological development of the French ground forces was limited by the rigid doctrine of the army; the French air force suffered from the opposite situation: a lack of clear doctrine providing consistent paradigms for the development of technology.

In the decade after World War I, French air doctrine developed little from the operations of 1918. Until 1933, the French air force was part of the army, and the army was primarily interested in reconnaissance, observation, close interdiction and air defense. The use of airpower was not a priority in the army doctrine of 1921; indeed, aviation was scarcely mentioned in the army regulations. In the 1930s the Commanders in Chief, Generals Weygand and Gamelin, demonstrated little knowledge or informed interest in military aviation.

The French air force was largely left to its own devices in developing doctrine, but even after it became an independent service, the air force generals lacked the status both within the military and within the French political system to further specific doctrines or approaches to technology. The army commander, as the military's supreme commander, had the status to establish doctrinal and strategic guidelines for all the services, but showed a lack of interest in aviation doctrine. This meant that the French air doctrine of the 1920s and 1930s became, by default, the responsibility of civilian air ministers, and with changes in air ministers, doctrine changed dramatically.⁶⁴

Anthony Adamthwaite, **France and the Coming of the Second World War**, London: Frank Cass (1977), p. 162.

⁶³Robert Frankenstein, **Le Prix du Réarmement Français 1935-1939**, Paris: Publications de la Sorbonne (1982). In the 14-billion-Franc rearmament program of September 1936, only 4.3% of the equipment funds were devoted to anti-aircraft defense. Up to 1940, the mainstay of the French anti-aircraft force was a slightly improved 75mm gun from World War I. The armament programs of 1937-1939 funded only 356 new 75mm anti-aircraft guns. See Ministère de la Defense, **Les Programmes d'Armement**, pp. 182-183.

⁶⁴General Gamelin, appointed as Supreme Commander of the armed forces in 1938, was unsure of the parameters of his authority to command the air force. In 1938-1939, he requested, but did not receive, clarification from the government. See Martin Alexander, **The Republic in Danger: General Maurice Gamelin and the Politics of French Defense, 1933-1940**, Cambridge University Press (1992), p. 168.

Though the French air arm had mainly an army support function in the late 1920s, the strategic bombing theories of the Italian General, Douhet, gained a wide acceptance among the air force officer corps. In the late 1920s, a program to produce a "battle plane" in accordance with Douhet's doctrine was initiated. Known as the "BCR" (**B**attle, **C**ombat, **R**econnaissance) aircraft, this multi-seater, two-engine craft would carry out army support functions and also be able to reinforce the heavy bomber force in carrying out long-range, strategic operations. This attempt to apply Douhet's doctrine to technology resulted in a series of thoroughly inferior multi-purpose aircraft, which proved to be mediocre in each mission. In January 1936, Pierre Cot became French Aviation Minister, and inaugurated a series of major rearmament programs for the Air Force. Due to the poor performance of the aviation industry in developing and manufacturing aircraft, Cot initiated a program to nationalize and rationalize French aviation production. By infusing the aviation industry with large amounts of new capital, he hoped to create the large air force France needed. From 1936 to 1938, under Cot's Ministry, the primary focus of the French Air Force was in building a strategic bomber force. Cot firmly believed in the offensive mission of the air force, and was an enthusiast for Douhetian doctrine.⁶⁵ In 1938, however, when the government changed and Cot was removed, the new Air Minister, Guy LeChambre, began a new armaments plan for the Air Force, known as "Plan 5". Plan 5 rejected the emphasis on bomber production, and instead placed the production and development emphasis upon fighter planes.⁶⁶ Guy LeChambre's vision of airpower was essentially the same as General Gamelin's, in that the priority of the French Air Force was

⁶⁵On the influence of Douhet upon Pierre Cot and the French Air Force, see Thierry Vivier, "Pierre Cot et la Naissance de l'Armée de l'Air", in Revue Historique des Armées, No. 181 (December 1990), pp. 108-115, esp. pp. 109-110. Pierre Cot's views on strategic bombing and nationalization are explained in his Book, L'Armée de l'Air, Paris: Éditions Bernard Grasset (1939).

⁶⁶This was a regression to the French combat doctrine of the 1920s. The 1928 Air Service Operational Doctrine stressed the need to gain air superiority. Air Superiority would not, however, be gained by bombing enemy airfields or infrastructure, as in German doctrine. Air superiority would be gained by masses of fighter planes over the front, in French doctrine. See Ministère de la Guerre, Règlement Provisoire de Manoeuvre de l'Aéronautique, vol. II (1928), paras. 1-4 and 6-7.

to form a defensive line to protect army operations.⁶⁷ Bombing became a secondary mission. Thus, by the outbreak of the war, the French had in one decade undergone three major changes in operational doctrine, all instituted by the Air Ministry. The nationalization program by the war's outbreak had produced results in increased aircraft production. Nevertheless, French aircraft production continued to lag behind that of the Germans. The German policy tended toward the standardization of a few kinds of aircraft for specific missions. For example, the Germans built only one, single-engine fighter in quantity before World War II: the Me 109. The French, however, distributed aircraft production among the various aircraft companies, and ordered small quantities of many different aircraft models. The French were unable to achieve anything resembling economies of scale in the 1930s, so that by the war's outbreak, the French were flying a half dozen different single-engine fighters to Germany's one. The same situation existed for bombers and reconnaissance aircraft.⁶⁸ Naturally, this resulted in far more complicated logistics, supply and procurement problems for the French Air Force, and consequently low operational rates. On the military side, the French Air Force chiefs of staff in the 1930s showed little interest in operational innovation. The two French Air Force Chiefs of Staff prior to World War II: General Philippe Frequant (October 1936 to February 1938) and General Joseph Vuillemin (February 1938 to July 1940) initiated no programs for the air force beyond traditional technologies of standard bombers, fighters and reconnaissance models. Thus, in 1940, the French Air Force had no radar and little in the way of radio navigation equipment. In particular, after little serious study or experimentation, the French Air Force rejected the concept of the dive bomber. What is especially remarkable about the French Air Force is that, even in fields of aviation where doctrine demanded specific technical solutions, very little effort was taken

⁶⁷ General Gamelin referred to the Air Force in the 1930s as "The Shield of the Army." See Martin Alexander, The Republic in Danger, p. 150. Air Minister Guy LeChambre reported to the Aeronautical Commission in February 1938, "In the initial phase of the war, however, what we'll need above all is to put our airspace under lock and key, as we've done for our frontiers." See Martin Alexander, The Republic in Danger, p. 163.

⁶⁸ According to Emmanuel Chadeau, De Blériot à Dassault: Histoire de l'Industrie Aéronautique en France 1900-1950, Paris: Fayard (1987), p. 343, "In May 1940....the French forces employed 23 aircraft types, 38 models in 42 versions...."

to link the aircraft with the doctrine, with the exception of the ill-fated BCR Program. In a nation that has a strategic bombing doctrine, as France had until 1938, one might expect an emphasis upon long-range navigation and instrument flying, yet the French in the 1930s were far behind the Germans, Americans and British in developing basic navigational instruments.

The Effect of Technology on German Doctrine.

The Germans, like the French, firmly believed that doctrine should ideally help guide technological development. In the German case, both ground-force and air-force technology demonstrated the impact of operational doctrine upon equipment development and procurement.

Immediately after World War I, the German Army, led by Hans von Seeckt as Chief of the General Staff, instituted a massive study of the lessons of World War I, and to develop new operational doctrine for the army and the air force. In the period of 1919-1921, five hundred German officers--commanders, General Staff officers and technical experts--were put to work on committees analyzing every aspect of the operations of the war, from mountain operations to tanks, to bombing operations, to fighter defense. By 1921, the five hundred officers, including 130 airmen, had completed their thorough study of the war's lessons, and out of this was distilled the German operational doctrine, Army Regulation 487, ***Leadership and Battle with Combined Arms***.⁶⁹

Von Seeckt, who coordinated the post-war study of doctrine, took an entirely different position from the French military. Von Seeckt believed that maneuver, not firepower, was the dominant element in warfare, and that to execute maneuver, mobility was essential. Unlike the French, the Germans believed much more strongly in the offense. The Germans sought the means to get the armies out of the trenches and static battles, which were seen as ultimately to Germany's strategic disadvantage, and to win campaigns and decisions quickly, by maneuver and mobility. In contrast to the French, who affirmed the essential unity of the army,⁷⁰ von Seeckt and the Reichswehr maintained a doctrine of warfare which essentially relied upon the establishment of two, different armies. One army would be an elite force, heavily armed with the latest weaponry and

⁶⁹James Corum, **The Roots of Blitzkrieg**, University Press of Kansas (1992), pp. 37-43 and 144-155.

⁷⁰In response to DeGaulle's 1934 book advocating a separate, elite mechanized army, General Weygand replied, "Two armies, not at any price....We already have a mechanized, motorized, organized reserve. Nothing need be created." Cited in Paul-Marie De la Gorce, **The French Army: A Military-Political History**, N.Y.: George Braziller (1963), p. 273.

highly mobile. This army would be the offensive force, which would seek the decisive battle and out-maneuver its opponents. The second army would be primarily infantry, would not be as well-armed, and would primarily consist of reservists. This second army would act mainly in a defensive capacity.⁷¹

Again in contrast to the French, Army Regulation 487 emphasized in its preface that war was an art--albeit, a rational art--and not a science. There was little of the pseudo-scientific emphasis upon tables and formulae to be found in the French operational regulations of 1921 and 1936. Army Regulation 487 outlined a number of general principles to be followed, but no formulae. For example, the German operational doctrine de-centralized the operational leadership, and not only allowed, but insisted that junior officers would possess considerable initiative in command. Artillery, which in France was highly centralized, was decentralized in the German Army. The emphasis was not upon deploying large numbers of guns, as with the French Army, but rather upon rapidly deploying smaller numbers of guns. Army Regulation 487 emphasized combined arms operations, and airpower played an important part in the German Army operational regulations. In addition, due to the emphasis upon offensive maneuver, tanks were given an important role in German doctrine of the 1920s.⁷²

This operational doctrine led the German Army in a number of technological directions. For instance, the mobile battlefield required mobile communications. Accordingly, the Germans set about in the 1920s to develop an entire family of army and air force radios for rapid communication. German doctrine also implicitly emphasized coordination of the air and ground forces at the operational level, as well as the use of tanks and armored vehicles. Finally, the doctrine of maneuver warfare pushed the German Army toward an intensive study of motorization. By 1926, the first table of organization and equipment for a motorized division, and tables of organization and equipment for mechanized brigades, had been set out in detail by the General Staff.⁷³

Technological Development and German Air Doctrine.

⁷¹James Corum, **The Roots of Blitzkrieg**, pp. 28-34 and pp. 200-201.

⁷²Ibid., Chapter 6.

⁷³Organization of Motorized Division and Motorized Brigades, in **Truppenamt T-4, Winterkriegsspiel 1926-1927**, BA/MA RH 2/2822. On TOEs for armor regiments, see **Heeresdienstvorschrift 487 Part II** (1923), paragraphs 524-525.

In the 1920s, within the German Army, a secret air staff was set up to perform the functions of an air force general staff, in the expectation of eventual rearmament, and the creation of an independent air force. Between 1919 and 1921, the Air Staff carried out a comprehensive study of World War I, and established a number of principles of air war, which would form the basis for German air doctrine in the interwar period.

The German air doctrine of the 1920s was set out in the Directives for the Operational Air War, written in 1926.⁷⁴

The conclusion of the Air Staff from their study of World War I was that airpower was intrinsically most effective in the offense, not the defense. Even though German airmen had fought a defensive air war during World War I, and had enjoyed an extremely high kill ratio versus the Allies, they discovered that a strong aerial defense did not lend itself to decision in war.⁷⁵ Therefore, the Germans concluded that bombers were the primary weapon of the air arm. In an air campaign, the first priority of the air force would be to gain air superiority. The air superiority battle would be won by taking the war to the enemy and destroying his air force, preferably on the ground, in his airfields. Once air superiority had been gained, the air force would move to the interdiction and strategic bombing missions. Like the army, the air force doctrine essentially outlined the creation of two air forces: one air force would be an army support force, flying short-range reconnaissance missions, observation missions, providing fighter defense for the army, and carrying out ground attacks. The second air force would be an independent air force serving under the strategic but not operational direction of the High Command. The independent air force had a strategic mission. The operational air force's strategic mission was not solely to bomb cities or industries deep in the enemy heartland--although this was a possible mission. The German concept of strategic air war was based upon strategic effect. The independent air force, essentially a bomber force and a long-range force, would be directed toward those targets that would produce the most decisive effect. This could sometimes entail bombing the enemy armaments industry, but in other cases, it could entail direct bombing the enemy army or his transportation.⁷⁶

German air doctrine of the 1920s applied some of the Prussian Army's most traditional principles to the new

⁷⁴ *Richtlinien für die Führung des Operativen Luftkrieges*, May 1926.

⁷⁵ Ibid., paragraphs 1-7. Ibid., para. 40: "A delaying action in the air or a purely defensive approach does not describe the true character of the air force."

⁷⁶ Ibid., paras. 83-85 and 91-95.

aerial weapon. First of all, airpower would be used in mass, and not distributed in small packets. Second, the strategic air force would maintain a large operational reserve, ready to exploit opportunities. Third, airpower would be used at the decisive point.

In 1935, the reestablished Luftwaffe published a new operational regulation, Luftwaffe Regulation 16: **Conduct of the Air War**. The essential principles of air war that had been developed in the 1920s were outlined in greater detail. However, the basic lines of doctrinal evolution remained unchanged. This doctrinal stability was of great benefit in developing weapons and equipment. The Luftwaffe that went to war in 1939-1940 was the bomber-heavy force that was called for by the doctrine of the interwar years.⁷⁷ The dive bomber, under study and development since the mid-1920s, was available for the CAS mission and also to hit strategic targets. The German doctrine called for fighter escort of the bombers so the Me 110 long-range fighter was developed for this purpose. Army/Air Force cooperation was an important part of doctrine so a considerable organization equipped with mobile communications systems was created.⁷⁸ Consistently, the deficiencies in the German doctrine also resulted in deficiencies in equipment development and procurement. The best illustration of this principle in the Luftwaffe is found in the lack of interest in doctrine for naval aviation before World War II. At the outbreak of the war modern combat aircraft designed for long range anti-shipping strikes and torpedo attacks were not available. The naval air arm had to make do with relatively obsolete, low performance seaplanes. It was a deficiency that would hurt the Germans considerably when they went to war against Britain.⁷⁹

⁷⁷In April 1940, the combat forces of the Luftwaffe included a total of 1,620 fighters, 1,726 bombers, 419 dive bombers and 46 ground attack planes, for a ratio of 1.4:1 bomber/attack aircraft to fighters. See Williamson Murray, **Strategy for Defeat: The Luftwaffe 1933-1945**, Maxwell AFB: Air University Press (1983), pp. 32-33.

⁷⁸Michael Forget, "Die Zusammenarbeit zwischen Luftwaffe und Heer bei den Französischen und deutschen Luftstreitkräften im Zweiten Weltkrieg", in **Luftkriegführung im Zweiten Weltkrieg**, ed. Horst Boog, Herford (1993), pp. 497-525, esp. pp. 511-512.

⁷⁹In October 1939, Navy Commander Admiral Raeder wrote to Reichsmarschall Göring to complain of the poor performance and capabilities of the Do 18 and He 115 Seaplanes, which were the backbone of the Naval Air Arm. Raeder argued that the Navy urgently needed aircraft with effective range, plus torpedo and bombing capability. See Admiral Raeder to Göring, Letter of October 31, 1939, in BA/MA RM 7/168.

The Influence of Organization upon Technical Development.

The French Army and Air Force were poorly organized to develop and oversee the production of modern equipment. From the end of World War I until the early 1930s the French Army possessed no centralized office specifically charged with the responsibility for developing and evaluating new technology. In the post war era, each of the major branches of the army (infantry, cavalry, engineers, artillery etc.) had its own technical office and was responsible for developing the equipment that pertained to that branch. The infantry branch, for example, had responsibility for tank development as tanks were considered to be an auxiliary of the infantry. Development of other armored vehicles such as armored cars were, however, the responsibility of the cavalry branch. No section of the General Staff carried the authority to coordinate branch weapons programs or to ensure an objective program of testing.⁸⁰ While each branch technical office contained some officers who were qualified and even highly talented in technical matters there existed no comprehensive or systematic program of cooperation between the branches. Development in the French Army was carried out in a fragmented, compartmentalized manner. In the early 1930s under the initiative of General Weygand, then Vice-President of the Conseil Supérieur de Guerre, some attempt was made to bring order to the process. A Consultative Council on Armament was created consisting of the senior branch inspectors, General Staff department heads and the Chief of the General Staff. A Technical Cabinet was created to act as a central office for research, testing and manufacture. Yet, the reform had only a partial effect. The actual development of weapons and the establishment of the specifications for the equipment still resided within the branches of the army. In 1933, the energetic and capable war minister Eduard Daladier created a new department for the manufacture of armaments which would execute the armaments plans formulated by the branches, but supervision over the departments themselves was still lacking.⁸¹ Finally, in 1935, the Technical Cabinet was replaced by a new section for armaments as a permanent office of the General Staff. However, this new section carried relatively little formal authority to coordinate the development and procurement process.

⁸⁰ Eduard Daladier complained in May 1937 of the extreme delays in equipment development and production caused by the Army branch inspectorates. The Armaments Council lacked both a proper staff, and audit powers. See Martin Alexander, **The Republic in Danger**, pp. 118-119.

⁸¹ See Robert Doughty, **The Seeds of Disaster**.

The French Air Force's development of equipment suffered from organizational problems within the French aviation industry and especially within the Aviation Ministry. The first problem of the air force was one of command authority. In wartime, the air force was subordinate to the army. In peacetime, however, the air force operated under the Ministry of Aviation. In 1928, when the Aviation Ministry was created, the air force was still a branch of the army and the French aviation industry was in a state of decline. In the 1920s the aviation industry lived primarily from small orders from the military. Although in the 1920s into the 1930s the French commercial air lines received the highest subsidies in Europe,⁸² the French aviation industry made little progress in developing modern and competitive transport planes or an infrastructure of modern airfields.⁸³ Indeed, waste, mismanagement, and even criminal fraud seems to have soaked up funds provided to French civilian aviation. The Aeropostale scandal of 1933, in which airline officials were found guilty of graft and theft, was one of the scandals that triggered the nationalization of the aircraft industry in the mid-1930s. While there were good arguments for nationalizing the aircraft industry, there are many examples of the negative effect that the nationalization had upon production and development of aircraft. Ministry politics seems to have played as large a role in the development and production of aircraft as the requirements of national defense. Marcel

⁸² Ronald Miller and David Sawers, The Technical Development of Modern Aviation, London: Routledge (1968), p. 15. The French airlines, while the most heavily subsidized, were also the most inefficient. In 1928, the French airlines received only 10.6% of their income from purely commercial activities. Lufthansa, which carried far more traffic than French airlines, earned 30% of its income from purely commercial activities, not including mail service, in 1929.

⁸³ French commercial aircraft design of the interwar period lagged far behind that of the other major powers. The Germans made great advances in the use of metal and in the construction of wings, in such aircraft as the Junkers F 13, W 33 and W 34. The Junkers trimotors, G 24 and Ju 52, were very popular outside of Germany. By the 1930s, the Ju 86 and Focke Wulf Condor were in use in German commercial aviation, and were sought by other countries. The only French commercial transport of note was the Bloch 220--and only 16 of these were built before World War II. See Peter Brooks, The Modern Airline: Its Origins and Development, London: Putnam (1961), pp. 52-57 and 88-93, also Enzo Angelucci and Paolo Matricardi, World Aircraft: Commercial 1935-1960, Chicago: Rand McNally (1979), pp. 188-189, on the Bloch 220.

Bloch-Dassault, owner of Bloch Aircraft Company and one of the leading aircraft designers in France (Bloch-Dassault would later design the Mirage Jet) was removed as director of his company when nationalization came. A year later, Bloch was asked to return but he was dismissed again in 1939.⁸⁴ The Air Ministry, a bloated and poorly-organized agency (When it was established in 1928 there were over 1,000 ministry employees in the Paris headquarters alone) had notoriously poor relationships with manufacturers and commercial organizations.

While the Air Ministry performed poorly in its duty to further development of aviation technology, the French Air Force leadership deserves much of the blame for France's position in 1940. While the Air Force carefully followed the development of aircraft there was little planning in the Air Staff for the matériel and personnel requirements of maintaining the aircraft and equipment required for a modern air force. At the outbreak of the war, the French Air Force had only 40% of their required radiomen and 23% of the required mechanics. A special commission was set up by the air force to determine personnel needs on 26 September, 1939--almost a month after the outbreak of war.⁸⁵ Other examples of poor industrial planning by the staffs abound. At the outbreak of the war, French production plummeted due to the call-up of skilled aircraft factory technicians to serve as reserve infantrymen at the front. Later in 1939, many soldiers were released from duty in the army to return to war production.⁸⁶ Numerous similar occurrences happened in the for the manufacture of armaments for the army. Renault's largest tank plant was almost closed in September, 1939 due to the call-up of skilled workers.⁸⁷ With decades to plan for a major war, neither the French Air Force or the French Army had developed a staff or adequate plans for coordinating the economic side of warfare. The failure of the French Air Staff to plan or organize for the broader requirements of technology was directly translated into extremely low readiness rates for French aircraft in May, 1940. Exact figures for aircraft operational rates are not available (another sign of French disorganization) for May, 1940 but a fair estimate from the numbers of aircraft that flew on missions is an average operational rate of about 50-60% for fighter units and no

⁸⁴ Jack Gee, Mirage, London: MacDonald (1971), p. 8.

⁸⁵ See Charles Christienne and Pierre Lissarrague, A History of French Military Aviation, p. 335.

⁸⁶ Alistair Horne, To Lose a Battle: France 1940, London: Penguin Books (1969), pp. 127-128.

⁸⁷ Martin Alexander, The Republic in Danger, p. 371.

more than 40% for bomber units.⁸⁸ Even today, no one is sure of how many aircraft were grounded for lack of bombsights, radios, machine guns or other basic equipment--but even the official histories imply that the numbers were in the hundreds.⁸⁹ The Germans began the campaign in 1940 with significant aerial superiority.⁹⁰ The lack of coordination and planning by the French Air Force ensured the Germans a decisive margin of superiority.

German Organization and Technology.

The Reichswehr's approach to developing equipment in the 1920s and 1930s was almost opposite to the French methodology. General von Seeckt, as Army Commander in Chief from 1920-1926, reorganized the Army Headquarters and General Staff to provide clear lines of responsibility for technical development as well as a centralized agency for technology within the army. As with the French Army, the German General Staff (Truppenamt) consisted of the normal departments; Army Organization, Training, Intelligence, Operations and Logistics. Under the General Staff came the inspectorates for the various branches of the army. A parallel organization to the Truppenamt, the Waffenamt or "Weapons Office" was created. The Waffenamt, which had as its chief a general of equal rank to the chief of the Truppenamt, had approximately as many personnel as the Truppenamt.⁹¹ Under the Waffenamt stood inspectorates for

⁸⁸Williamson Murray in **Strategy for Defeat**, p. 36, estimates a French operational rate of no more than 40% for many squadrons before May 1940. French historians indicate a very low operational rate during May 1940. Group attacks were consistently made with 40-50% of the group's official strength. See Pierre Paquier, **l'Aviation de Bombardement Française en 1939-1940**, Paris: Berger-Levrault (1948), pp. 8-9 and 208-235, for a log of French air activity between May 10-20, 1940.

⁸⁹See Charles Christienne and Pierre Lissarrague, **History of French Military Aviation**, pp. 336-370.

⁹⁰In May 1940, the French Air Force had over 2,200 aircraft available. See Lucien Robineau, "Die französische Luftpolitik zwischen den beiden Weltkriegen und die Führung des Luftkrieges gegen Deutschland (September 1939 bis Juni 1940)", in **Luftkriegführung im Zweiten Weltkrieg**, ed. Horst Boog, Herford: E.S. Mittler & Sohn (1993), pp. 723-756, esp. p. 739. In May 1940, the RAF in France had about 400 aircraft. See Derek Wood and Derek Dempster, **The Narrow Margin**, Washington, D.C.: Smithsonian Institution Press (1990), p. 126. The German Air Force had approximately 3,600 aircraft to oppose the Allies in May 1940.

⁹¹In the mid-1920s, the Waffenamt employed 64 officers, including 2 major generals, two colonels and 12 lieutenant

weapons development which corresponded to the Truppenamt's inspectorates. It was the duty of the General Staff inspectorates to develop ideas, doctrine and training programs for new equipment as well as requests for research and specifications for new weapons. The inspectorate worked together with its corresponding Waffenamt inspectorate which would develop prototypes and conduct testing. The responsibility for the development of weapons and equipment lay directly in the hands of the Chief of the Waffenamt who reported directly to the Army Commander in Chief and the Defense Minister.⁹²

Unlike the compartmentalization of the French system, the development of technology was seen as a coordinated whole and several inspectorates would cooperate on the development of some items of equipment. For example, the chief responsibility for the development of tanks lay with the motor vehicle section of the Waffenamt which worked together with the Inspectorate of Motor Vehicles in the Truppenamt. However, representatives from the Inspectorate of Communications Troops were also assigned to the armor projects in order to ensure radios were developed for the tanks. The artillery inspectorates were assigned the responsibility for developing tank guns and also had members assigned to tank development projects.

Realizing the importance for production planning in modern warfare, a war economics office was created in 1926 and reported to the Army Commander. the assignment of the war economics office was to maintain contact with armaments industries, collect information and carry out planning for industrial mobilization.⁹³

This system, which the Nazis inherited in 1933, worked fairly rationally to create prototypes of equipment which matched doctrinal requirements with considerably less duplication of effort than the programs of the French General Staff. The French, for example, had two sets of tank programs in the 1930s--one in the Infantry inspectorate and the other in the Cavalry Inspectorate. The economics planning office was never able to effectively meet the enormous task given to it. However, again in contrast to

colonels. An additional 21 officers worked at test sites for the Waffenamt. See Wehrministerium, **Rangliste des Deutschen Reichsheeres**, Berlin (1925).

⁹²A good overview of the Waffenamt operations can be found in Erich Schneider's "Waffenentwicklung: Ehrfahrungen im deutschen Heereswaffenamt", in **Wehrwissenschaftliche Rundschau**, vol. 3. (1953), pp. 24-35.

⁹³On the economic mobilization plans of the German Army, see George Thomas, **Geschichte der deutschen Wehr und Rüstungswirtschaft (1919-1943/45)**, Boppard am Rhein: Harold Boldt Verlag (1966), pp. 53-57.

the French, by the outbreak of the war at least a rudimentary personnel plans had been set which exempted skilled civilian workers in the armaments industries from military service. The Germans in the early months of the war experienced only minor reductions in some areas of production due to the call-up of reservists.⁹⁴ For the development of military aviation technology, the Germans had to rely upon a more awkward organizational system due to the ban on military aviation required by the Versailles Treaty. The shadow air staff had representatives spread throughout the General Staff. For example, the Intelligence Section contained one or two airmen who specialized in air intelligence. Sections for aviation were distributed within the Weapons Office. Also involved in development of aviation technology was the aviation department of the Ministry of Transportation. The Aviation Department was responsible for regulating all aspects of German civil aviation.

Despite this awkward system, which did not provide for any single agency for development of aviation, the Germans managed to forge ahead in development and, by 1927, develop aircraft technology superior to France's.⁹⁵ The cause for the successful rebirth of German aviation in the 1920s was the extraordinary level of cooperation between the armed forces, the Aviation Department of the Transportation Ministry and the civilian manufacturers. The German Undersecretary for Aviation from 1923-1934 was Captain Ernst Brandenburg, wartime commander of the 1st Bomber Wing which had carried out the strategic campaign against London with Gotha bombers in 1917-18. Brandenburg, who was appointed at the insistence of the Army Commander von Seeckt, worked to develop German civil aviation as a basis for later aerial rearmament.⁹⁶

Civilian aviation was staffed throughout by former pilot officers who retained a reserve status with the shadow Luftwaffe. Information on all the latest developments in

⁹⁴ See Richard Overy, The Air War: 1939-1945, N.Y.: Scarborough House (1980).

⁹⁵ By 1928, Germany had taken from France numerous official aviation world records, for altitude, distance and duration. A German-crewed Junkers W 33 aircraft crossed the Atlantic before a French team in 1928. See L. Hirschauer, ed., l'Année Aéronautique 1928-1929, Paris: Dunoud (1929), pp. 98-100, 167, and 245. In 1929-1930, the Germans developed the 4-motor Junkers G 38 aircraft, the largest commercial aircraft of the time, with 3,200 horsepower and 38-passenger capacity. See Peter Supf, Das Buch der deutschen Fluggeschichte, vol. II, p. 613.

⁹⁶ Friedrich von Rabenau, Seeckt: Aus seinem Leben, Leipzig: Koehler Verlag (1940), p. 529.

aviation, navigation, equipment and foreign aircraft types was collected by the Air Staff. Ehrhard Milch, a wartime captain of the Air Service and a director of Lufthansa, carried on an extensive correspondence with the Air Staff in the 1920s providing Lufthansa's experience in long-range navigation, aircraft engines, new instruments etc.⁹⁷

Manufacturers such as Ernst Heinkel worked closely with the air staff to develop new aircraft at a time when the Inter-Allied Control Commission had shut down German aviation.⁹⁸

In 1926, senior Lufthansa manager (and wartime air officer) Dr. Robert Knauss made a pioneering long-distance flight from Berlin to Peking. Upon his return to Berlin, he delivered his flight logs to Lt.Col. Wilberg, chief army staff officer for aviation.⁹⁹

With a smaller budget than the French, the civil aviation department used its money wisely to develop the necessary basic infrastructure for modern aviation.¹⁰⁰ The level of research on aviation carried out in German institutes of the 1920s and early 30s was equivalent to the level of French research. By the late 1920s, the Germans had planned for a limited rearmament and the secret air staff accelerated work in developing prototypes for a reborn German air force.

With a realization that the air staff system of the Reichswehr General Staff was diluted among too many offices, General Blomberg in 1932 prepared and won approval for a plan to consolidate all the Reichswehr air activities into one department which would be called the "Air Defense Office".¹⁰¹ Colonel Wilhelm Wimmer, active in the development of military prototypes since the 1920s, became head of the Technical Office under the new organization.¹⁰²

⁹⁷The German military archives contain numerous letters and reports written by Milch, as Lufthansa Director, to the Chief Air Staff Officer. For example, in 1928 Milch wrote air staff officer Major Sperrle a friendly report on Lufthansa's experience with the reliability of various radio models. See BA/MA RH 2/2222, ***Correspondence File of 1928***.

⁹⁸Ernst Heinkel, ***He 1000***, London: Hutchinson (1956), pp. 78-79.

⁹⁹Interview by Author with Hansgeorg Wilberg, son of General der Flieger Helmuth Wilberg, June 18, 1992.

¹⁰⁰Between 1926 and 1932, the German aviation industry received 321 million Reichsmarks in government subsidies, investment, research funds, et al. According to the exchange rate of the time, this amounted to \$12.42 million per year. See Ralf Schabel, ***Die Illusion der Wunderwaffen***, Munich: Oldenbourg Verlag, p. 103.

¹⁰¹Mathew Cooper, ***The German Air Force 1933-1945***, London: Jane's (1981), pp. 2-3.

¹⁰²Edward Homze, ***Arming the Luftwaffe***, University of Nebraska Press (1976), p. 59.

Under the new Air Ministry, established in 1933, Wimmer and the Army's aviation experts argued for building up the very small German aviation industry (battered by the depression, German aircraft manufacturers had only 3,200 workers in 1932)¹⁰³ by contracting for moderate numbers of relatively mediocre aircraft already developed such as the He 51 and Arado 68 fighters and Ju 52 and Do 23 bombers. While the aircraft industry expanded to fill the initial orders, a second generation of high performance aircraft were developed. This second generation developed under the tenure of Wimmer as chief of the Technical Office included the Me 109, Me 110, Do 17, He 111 and Ju 87--all aircraft on the cutting edge of technology of the era.

There were numerous inefficiencies in the Luftwaffe's prewar rearmament program, not least the appointment of Udet to serve as chief of the Technical Office. Whereas the second generation of German aircraft was developed with great rapidity the third generation was plagued by delays caused by constant redesigns. In one case, a very effective bomber, the Ju 88, was delayed by Udet's insistence that it be capable of dive bombing. With the exception of the FW 190 fighter, the third generation of Luftwaffe aircraft (Hs 129, Me 210, He 177) were disappointing aircraft. The problem with over-centralized control is that when the person at the center is incompetent, the damage can be great. However, with the exception of Udet's appointment, Reichsmarshal Hermann Goering, who had little understanding of modern aviation, interfered little with the technical decisions made by his generals in the prewar period. Even Udet could make some technical decisions more astute than those of the French leaders. For example, in 1936 Udet decided that the Me 109 would be Germany's only single-engine fighter. This ensured that mass production and economies of scale would give the German fighter force superiority over the French in 1940.

Military Culture and Technology.

The tradition and culture of the German General Staff enabled it to adapt at a rapid pace of technical development and experimentation in the interwar period. The tradition of the General Staff, which was maintained and strengthened under the tenure of Hans von Seeckt, emphasized a logical and critical approach to questions of operational doctrine, military organization and equipment. The General Staff Corps had great prestige within the army and the officers selected for the General Staff were allowed a considerable degree of freedom to question, criticize and propose new ideas. While the senior commanders of the army were expected to have strategic and operational vision, even the

¹⁰³ Edward Homze, Arming the Luftwaffe, p. 73.

junior officers of the General Staff were allowed and encouraged to make modifications and contributions to the ideas proposed by their seniors. In short, the General Staff Corps saw itself as a collective body which had the responsibility to develop ideas.

One of the most characteristic expressions of the German military culture was the *Denkschrift*, literally "Thought Paper". Officers would propose ideas or critique ideas in essays circulated throughout the General Staff. The tradition of the General Staff was such that these essays were read by the senior commanders, and often acted upon. At the very least, the *Denkschrift* would provide a framework for debate.

In the immediate aftermath of World War I, two important *Denkschriften* concerning war and technology were circulated among the High Command. The first was von Seeckt's proposal for a small, elite and highly mobile professional army. Maneuver warfare, von Seeckt argued, required a professional force because only a highly-trained elite force could hope to effectively use the complex modern weapons and move with rapidity to gain the decision.¹⁰⁴ The second influential *Denkschrift* was "The Technical and Tactical Lessons of the World War", written by Colonel Kurt Thorbeck in 1920. In it, Thorbeck ruthlessly criticized the General Staff for not having officers conversant with the technical and material demands of war. He called the General Staff's lack of technological familiarity "the basic mistake of the war."¹⁰⁵ Thorbeck's critique would lead to a major reform of military education and culture under von Seeckt.

The tradition of the *Denkschrift*, combined with a tradition of critical examination, meant that the role of technology was emphasized in the comprehensive study of the lessons of the war carried out in 1919-1920.¹⁰⁶ One of the most important, and also the most overlooked, reforms that von Seeckt made in the German General Staff was a new program to provide technological expertise to the General Staff. Before World War I, entry into the General Staff had been by competitive examination and the three-year course at the *Kriegsakademie*. Starting in the early 1920s, officers could

¹⁰⁴ Hans von Seeckt, *Denkschrift an der Heeresleitung, February 18, 1919*. U.S. National Archives German Records. Von Seeckt Papers, File M-132, Roll 21, Item 110.

¹⁰⁵ Colonel Kurt Thorbeck, "Die Technische und Taktische Lehre des Krieges", April 12, 1920, BA/MA RH 12-2/94.

¹⁰⁶ Erich von Manstein, who worked in the General Staff Operations Section after World War I, recorded that the top priority of the Operations Section in the 1920s was developing new weaponry, especially armored vehicles and the motorization of the army. See Erich von Manstein, *Aus Einem Soldatenleben*, Bonn: Athenäum Verlag (1958), p. 110.

enter the General Staff by attending a civilian university or technical college, and earning a technical degree. Approximately 10 officers per year (out of a total officer corps of 4,000) were selected by the Reichswehr for attendance at civilian engineering programs, their fees paid by the army. When the course was completed, the officer would return to regular duty, usually serving as a specialist with the Waffenamt.¹⁰⁷ Many of the officers, however, were also given the opportunity for troop commands. Some of the most senior Wehrmacht leaders of World War Two took engineering degrees in lieu of the Kriegsakademie--notably, Field Marshal Wolfram von Richthofen, who earned a doctorate in engineering at Reichswehr expense.¹⁰⁸ Along with the program in technical education, von Seeckt also insisted upon an informal system of technical education within the officer corps. Dissatisfied with the level of knowledge of technology and foreign weapons demonstrated by the General Staff officers, von Seeckt instituted a program of bimonthly seminars for the officers in the Truppenamt, who would spend the morning or afternoon being briefed on the latest technical developments by experts from the Waffenamt.¹⁰⁹ Through his insistence upon technological literacy, and by encouraging the serious study of engineering by the officer corps, von Seeckt helped ensure that the officer corps as a whole would be infused with an interest in, and appreciation for, technology. One example of technology being developed within the General Staff tradition is the effort of Erich von Manstein toward promoting the concept of the assault gun, or *Sturmgeschütze* for the German infantry divisions. In 1935, von Manstein wrote a Denkschrift outlining his idea for creating an assault gun: a heavy gun mounted without a turret on a tracked chassis, that could provide limited armored support for infantry divisions which were faced with fixed enemy defenses. Such a gun would be cheaper and simpler to build than a tank, and would be of enormous value to the infantry in defense or offense. Manstein argued that a detachment of such guns should be assigned to each infantry division, while tanks should remain concentrated in the panzer

¹⁰⁷ Adolf Reinicke, Das Reichsheer, p. 312.

¹⁰⁸ Some of the notable German senior officers who were sent to receive engineering degrees by the Army in the interwar period include: Field Marshal von Richthofen (Engineering PhD.); Maj. Gen. Robert Fuchs, Commander, 1st Air Division; Gen. der Flieger Johannes Fink, Commander, II Air Corps; Maj. Gen. Friedrich Deutsch, Commander, 16 Flak Division; Lt. Gen. Gerhard Conrad, Air Commander, XI Air Corps; and Lt. Gen. Richard Schimpf, Commander, 3rd Paratroop Division.

¹⁰⁹ Hans von Seeckt to Waffenamt, and *Inspektionen*, January 21, 1924, BA/MA RH 12-2-21.

divisions. Guderian and the staff of the Inspectorate of Panzer Troops strongly opposed the idea of putting assault guns in the infantry divisions, but the infantry and artillery inspectorates saw merit in the idea.¹¹⁰ By 1937, development and testing of the assault guns was underway, and trials proved their feasibility. By the outbreak of the war, production of the assault guns was underway, and a detachment of the first models, with a 75mm gun mounted on the chassis of a Panzer III tank, proved their worth in battle.¹¹¹ The assault gun, developed in many versions, would become one of the most valuable battlefield weapons of the German Army in World War II.

Examples such as the assault gun demonstrate the importance of open and honest debate within the General Staff, and the possibilities for non-technical specialists to develop innovative solutions to operational problems. The interest of von Manstein in the details of new weaponry also illustrate the wide dissemination of technical knowledge and interests throughout the army in the interwar period.

The Luftwaffe: Leadership and Technology.

The Luftwaffe was the most technologically-oriented of the German services in the interwar period. The nature of the ban on military aviation during this period meant that the Luftwaffe had to be created in the early 1930s from a small corps of airmen retained by the Reichswehr after World War I. By necessity, the Luftwaffe had to rely upon the former officers and pilots of the wartime air service, who had served in civil aviation from 1919-1934. When rearmament came, there were several hundred wartime officers with combat experience, working for Lufthansa, for the aircraft companies, for the Air Department of the Transportation Ministry and in the civilian flight schools, who were eager to reenter the military and join the new Luftwaffe. Just how important these reserve officers were to aerial rearmament is demonstrated by the proportion of senior leaders of the Luftwaffe who came from interwar civil aviation: of the 600+ generals of the Luftwaffe serving between 1935 and 1945, approximately 150 had been involved with civil aviation between 1920 and 1934.¹¹² Erhard Milch,

¹¹⁰Erich von Manstein, **Aus Einem Soldatenleben**, pp. 246-249. Manstein's account of the Sturmgeschütze also provides a good picture of debate within the General Staff, and how the Army Weapons Office could move efficiently and quickly to develop an effective new weapon.

¹¹¹Walter Spielberger and Uwe Feist, **Sturmartillerie**, Part I, Fallbrook, Calif.: Arco Publishers (1967).

¹¹²Information from: Karl Friedrich Hildebrand, **Die Generale der deutschen Luftwaffe 1935-1945**, vols. I-III, Osnabrück: Biblio Verlag (1990). Hildebrand has published the official

State Secretary for Aviation and Field Marshal, served as a Director of Lufthansa before rejoining the military. General der Flieger Robert Knauss, later to be Commander of the Luftwaffe General Staff College, also came from the Lufthansa Board of Directors.¹¹³ Colonel General Alfred Keller, Commander of the First Air Fleet from 1940-1943, worked for Junkers and ran a flight school before 1934.¹¹⁴ Lt. General Werner Junck, wartime Commander of Jagdkorps II, worked for Heinkel before joining the Luftwaffe.¹¹⁵ Lt. General Osterkamp, a World War I pour le Mérite holder, managed a seaplane station prior to returning to the Luftwaffe. Osterkamp would become the Air Commander for North Africa in 1941-1942.¹¹⁶ Officers with a specialized technical background in civil aviation were enlisted into the technical and special staffs of the new Luftwaffe, and many rose to high rank. Several historians, including Richard Overy, have suggested that the Luftwaffe suffered from serious leadership problems, since such a large proportion of the Luftwaffe officers were brought in from civil aviation.¹¹⁷ Other writers, noting the several hundred officers transferred from the army in 1934-35--Wever, Kesselring, and Stumpf, to name a few--refer to the senior leadership of the Luftwaffe as "amateur aviators."¹¹⁸ Overy argues that there was a clash between the "Prussians", the regular officers who had remained with the Reichswehr, and the "Outsiders", who had

service records of all 688 men who reached the rank of General in the Luftwaffe.

¹¹³ Ibid.

¹¹⁴ Ibid.

¹¹⁵ Ibid.

¹¹⁶ Ibid.

¹¹⁷ Overy asserts that the inclusion of so many reactivated officers and officers from the army "had the unfortunate consequence of dividing the air officer corps into those who regarded themselves as heirs of the Prussian tradition, and those who came from an unorthodox, particularly technical background. Part of the hostility felt between regular soldiers and the parvenues arose from the fact that the newcomers were given high military office without having followed the normal army channels." See R.J. Overy, The Air War 1939-1945, Chelsea, Mich.: Scarborough House (1980), p. 137.

¹¹⁸ "The result of all this was that the Luftwaffe was shaped by aviators who were amateur soldiers, and soldiers who were amateur aviators." From Telford Taylor, The March of Conquest, Baltimore: Nautical and Aviation Press (1991 Reprint), pp. 25-26.

reentered the military in 1934-1935. This clash of cultures and viewpoints seriously damaged the Luftwaffe.¹¹⁹ Of course, there were serious personality clashes between senior officers of the Luftwaffe--as with any military service--but there is no evidence of animosity on the basis of "Prussian" or "Outsider" status. That Milch was disliked by many was more a function of his own personality than his service with Lufthansa. Even those who disliked him regarded him as highly competent.¹²⁰ Wever came from the army, but was nevertheless highly respected by the professional airmen of the Reichswehr.

I would argue that the influx of hundreds of reserve officers from civil aviation in the first stages of the German aerial rearmament was one of the great advantages that the Germans enjoyed in the interwar period. The officers from Lufthansa or Junkers were probably better informed about the nature of modern aircraft technology and the conditions of long-distance flying than regular French officers, who had led an air force garrison life of staff and flying jobs during this same period. The Luftwaffe's superior use of human resources is one factor which enabled the Germans to gain the technical advantage over the French in 1940. The director of airfield construction for the Luftwaffe was brought in from civilian life as an airfield construction engineer and professor of architecture at a civilian university.¹²¹ No professional military airmen knew more about the management side of aviation, nor had they achieved the same degree of success, as Erhard Milch. As to the amateur status of officers brought from the Army--many, like Kesselring, learned to fly and later proved themselves to be excellent operational air commanders.

The French Military Culture.

The French General Staff tradition was significantly different from that of the Germans. In the French tradition, the staff was no more than an organization to assist the commander. The direction, ideas and vision all flowed from the commander. Open debate of operational

¹¹⁹ Richard Overy, The Air War, p. 136.

¹²⁰ Field Marshal von Richthofen disliked and distrusted Milch for his "love of intrigue", but respected him as highly competent in aviation. From the Author's interview with Götz Freiherr von Richthofen, son of Field Marshal Wolfram von Richthofen, June 21, 1992.

¹²¹ Chief of construction operations for the Luftwaffe was Ministerialdirigent Professor Doktor Ingenieur Heinrich Steinmann, a World War I pilot who taught construction engineering at the Technische Hochschule in Braunschweig from 1926-1934. See Steinmann's record in Karl Friedrich Hildebrand, Die Generale der deutschen Luftwaffe.

concepts was not part of the French military culture. In contrast to the comprehensive and critical effort of the 500 officers who worked to develop German operational doctrine after World War I, the French operational regulation was drawn up by a committee of 13 officers.¹²² When Charles DeGaulle initiated a debate about the organization of a large armored force in 1934, he was punished by having his promotion to colonel delayed.

Professor Jenny Kiesling has argued that the French interwar army discouraged debate because, in an army dependent upon large numbers of reserve officers, bringing the doctrine of the army into question would indicate a lack of confidence and thus undermine morale.¹²³ Other factors may also have ensured a less critical approach by the French officer corps. If the French Army had initiated a comprehensive examination of the lessons of World War I, they would have had to discuss, and attempt to come to grips with, the scandalous mass mutinies of 1917, when half the divisions of the army were incapacitated by their refusal to attack. Although these mutinies were quelled by hundreds of secret executions, the French Army has, to this day, refused to examine those events.¹²⁴ An honest evaluation of the performance of the army and its senior officers would have probably crippled the army in its relations with the government.

Thus, in the interwar period, the French Army was dependent upon the understanding of technology possessed by its senior officers. The two most important commanders of the interwar period: Marshal Petain, Vice President of the War Council from 1920 to 1931, and General Gamelin, Army Commander from 1935 to 1940 and Chief of the Defense Staff from 1938 to 1940, were knowledgeable about most aspects of ground forces

¹²² *Report to Ministère de la Guerre, October 6, 1921*, from Preface to Ministère de la Guerre, Instruction Provisoire sur l'Emploi Tactique des Grandes Unites, Report of October 6, 1921. The committee that wrote the report consisted of General Georges (Chairman); ten army generals, three colonels, one lieutenant colonel and one major. Only one officer of the board, General Pujo, was an airman.

¹²³ E.C. Kiesling, "Reform? Why?: Military Doctrine in Interwar France", Paper read before the Society for Military History, April 8, 1994, p. 7.

¹²⁴ Between April and September 1917, serious mutinies broke out in 54 French divisions. The French Army was temporarily crippled. Over 20,000 men were found guilty of crimes by military courts. Hundreds of French soldiers were secretly executed--even today, the French will not release details. For an account of the mass mutinies in the French Army, see Richard Watt, Dare Call It Treason, N.Y.: Simon & Schuster (1963), esp. pp. 299-303.

equipment. Neither, however, had any understanding of aviation technology, and accordingly the French air weapon suffered from the senior commanders' neglect. Such German Army commanders as von Seeckt, Beck, von Blomberg and von Fritsch, on the other hand, demonstrated a strong interest in, and support of, military aviation.

The French also suffered from the lack of vision displayed by its commanders regarding motorization. To be sure, from the 1930s on, Gamelin placed a high priority upon the creation of motorized divisions, but his concept of motorization was essentially flawed. Gamelin was interested in motorization as a purely strategic concept: the creation of a motorized reserve force which could move quickly to Belgium in order to deploy against the Germans. Gamelin, moreover, had no concept of operational mobility: motorization helped infantry divisions move quickly by truck; once they arrived, they would dismount and fight like any other line infantry division.¹²⁵ Due to this lack of an operational concept, the French did not develop communications, armored carriers, self-propelled guns, etc. like the Germans--though the French did have the required expertise, and the industrial base.

The culture of the French Air Force command played a central role in that force's poor position in 1940. During the interwar period, the French Air Force had the aspect of a pilots' club. Commanders were interested in developing aircraft types, but little thought was given to creating the infrastructure of an operational force, or in planning for industrial mobilization. Like the Germans, the French possessed a large reserve of experienced airmen from the First World War who had entered civil aviation. As rearmament accelerated in the 1930s, however, the only interest that the regular air force officers had in their reserve officers was in their flying proficiency.¹²⁶ There was no search for skills outside the narrow field of piloting. France produced as many skilled aircraft engineers in the interwar period as Germany, but the French Air Staff had little interest in recruiting such men. The French interwar air force is one of the best examples in

¹²⁵On French concepts of motorized armor forces, see Jean DeLaunay, "Chars de Combat et Cavalerie (1917-1942): la naissance de l'arme blindée", in Revue Historique des Armeés, No. 155 (June 1984), pp. 2-18, esp. pp. 10-11. The concepts of mobility of Gamelin, Weygand and other senior generals is well-described in Paul Reynaud's Memoirs, In the Thick of the Fight 1930-1945, N.Y.: Simon & Schuster (1955), pp. 158-161.

¹²⁶See Thierry Vivier, "Les Réservistes de l'Air (1919-1939)", Revue Historique des Armeés, No. 174 (March 1989), pp. 63-76.

history of the misuse of excellent human resources. If Marcel Bloch-Dassault had been a German, instead of being fired he would have likely ended up a general in the Luftwaffe.

CONCLUSION

Many elements contribute to the technology of an armed force. The economic base of a nation, its educational system, its financial position, all are decisive factors and their importance should not be underrated. A comprehensive approach to the study of interwar technology would require a hefty volume. I have therefore confined myself to a few factors concerning the effect of military doctrine, organization and culture upon technology. My conclusion is that these factors have as much bearing upon the development, procurement and employment of weapons as the objective economic and scientific factors. Further, the comparison of the French and Germans in this period illustrates the importance of the individual military commanders upon the development of technology. One can plausibly assign some of the blame for the poor state of the French Army and Air Force in 1940 to the politicians and to the economy, but this does not absolve the commanders from failing in their duty to oversee the development of an effective doctrine, and effective weapons to match that doctrine. Despite the complaints of the official French histories concerning the lack of funding for the military in the interwar period, this was not the major cause for technological deficiency.¹²⁷ In those areas where the French provided higher funding than the Germans--notably, civil aviation--they still went to war with inferior technology. It is certainly not my intention to claim that the German approach was foolproof, or even particularly efficient. The Germans built their share of bad weapons and aircraft. As Richard Overy points out in War and Economy in the Third Reich, the war economy of 1939-1940 was extremely inefficient.¹²⁸ Volumes have already been written on the technological mistakes the Germans made before and during

¹²⁷ General Wegand, French Commander in Chief after Gamelin's relief in June 1940, argued that the ineffective armament of the French Army in 1940 was the responsibility of the military commanders--not just the politicians. See General Maxim Wegand, Histoire de l'Armée Française, Paris: Ernest Flammarion (1953), pp. 418-420.

¹²⁸ Richard Overy, War and Economy in the Third Reich, Oxford: Clarendon Press (1994), esp. chapters 8 and 9. Edward Homze, in Arming the Luftwaffe pp. 262-265, concludes that the German aviation industry was poorly managed in the 1930s.

the war.¹²⁹ The purpose of this paper is to compare the two approaches to technology, and the German approach still comes across by far as the most successful. It was primarily successful due to a military culture that encouraged innovation, discussion, debate and a comprehensive approach to the study of war.

¹²⁹A useful recent work outlining many of the inefficiencies of German aircraft production is Willi Boelcke, "Stimulation und Verhalten von Unternehmen der deutschen Luftrüstungsindustrie während der Aufrüstungs und Kriegsphase", in Luftkriegführung im Zweiten Weltkrieg, ed. Horst Boog, Herford: E.S. Mittler Verlag (1993), pp. 81-112.